

# Periodontitis: still more to learn about - Results of a telephone survey in Germany

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## Research Article

**Keywords:** Behavioral Research, Cross-sectional Studies, Dentistry, Oral Health, Periodontal Diseases, Psychology, Surveys and Questionnaires

**Posted Date:** March 11th, 2021

**DOI:** <https://doi.org/10.21203/rs.3.rs-266931/v1>

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# Abstract

**Introduction** Despite a broad public awareness of the need for good oral health, periodontitis is one of the most common chronic diseases worldwide. One explanation might be that people lack specific knowledge about the disease enabling them to proper oral health behavior. The present study aimed to assess the current periodontitis-related knowledge of the German population.

**Methods/Design** Former participants of the 5th German Oral Health Study (n = 333 16-year-olds, n = 307 39-48-year-olds, n = 332 69-78-year-olds) answered open-ended (OEs), single- (SCQs) and multiple-choice questions (MCQs) regarding periodontal diseases and oral hygiene behavior in a computer assisted telephone interview provided by professional interviewers.

OEs assess active knowledge, SCQs and MCQs help to identify passive knowledge (correct answers) and specific misconceptions (wrong answers). Answer frequencies and effect sizes of group differences (Cramer's V) are presented.

**Results** Active knowledge regarding the definition, risk-factors, consequences and prevention of periodontitis and regarding proper oral hygiene behavior was low. In SCQs and MCQs participants often chose wrong and right answer categories with comparable frequencies.

**Conclusions** Efforts to provide the population with comprehensive information on periodontitis must be intensified. The findings indicate that this educational work should begin at school age but must not end there.

## Introduction

Periodontitis belongs to the most prevalent chronic diseases worldwide (1). It is caused by persistent plaque deposits at the gingival margin that first lead to gingivitis and gingival pockets. These complicate oral hygiene and promote the colonization of gram-negative anaerobic bacteria. As a result, the inflammation progresses and begins to affect the whole periodontium by causing its inflammatory breakdown (2).

In its early stages periodontitis causes loss of gingival attachment and exposed tooth necks. This increases the risk of caries of the respective tooth as the exposed necks are missing the protective layer of enamel that covers the rest of the crown. In its advanced stages attachment loss increases tooth mobility and may lead to tooth loss (2). Beside these consequences, affecting the integrity of the dentition itself periodontitis is also considered to have adverse systemic consequences caused by bacteremia and the host's response to it (1). Among them are an increased risk of cardiovascular disease, poorly managed diabetes, preterm birth and low birth weight and as recently discussed Alzheimer dementia (3, 4). Periodontitis is thus a serious disease both affecting the integrity of the dentition and increasing the risk of serious systemic conditions. It entails high direct and indirect health care costs (5)

Accordingly, it is not only in the interest of the individual but also of the society as a whole to take effective preventive measures against it.

Oral health education thus plays a key role in the primary, secondary and tertiary prevention of periodontal disease (6, 7). One aim of oral health education is to ensure that people are actively aware of crucial issues regarding etiology, risk factors, consequences and preventive measures of oral diseases so that they can adapt their behavior accordingly. A recent systematic review, however, identified significant deficits regarding periodontitis related knowledge on a population level in different regions of the world (8). In that review no difference was made whether knowledge was assessed via single- or multiple-choice queries or via open-ended questions. A major advantage of single- or multiple-choice queries is that they help to better understand implicit ideas of people regarding a specific topic especially when their active knowledge is low. A significant disadvantage is, however, that they assess passive recognition or even guessing of the correct answer rather than active knowledge. Yet, it is this active awareness, which is essential for the proper exercise of a health behavior. Open-ended questions allow for the assessment of this active awareness.

One study cited in the review has shown this quite clearly (9). During a telephone survey people were first asked open-ended questions and afterwards were presented single- or multiple-choice queries regarding the same topic. As expected, deficits regarding knowledge about the etiology, risk factors, health consequences and preventive measures regarding periodontal diseases were most obvious in answers to open-ended questions. At the same time, the single-choice or multiple-choice queries clarified a number of misconceptions of the interviewees on various topics related to periodontitis (9). This study was conducted in Germany in 2007 and might thus not be up to date. In the meantime several campaigns on national levels were run by local periodontal societies aiming to increase people's knowledge about periodontitis (e.g. the <https://www.efp.org/newsupdate/efp-launchesn-caries-gum-disease-campaig/>). Additionally, the recent 5th German Oral Health Study (DMS V (Deutsche Mundgesundheitsstudie V) observed a decrease in the prevalence of severe and moderate periodontitis from 2005 to 2014 though prevalences remain above 50% both in younger adults and seniors (10). One aim of the present study was thus to examine current periodontitis-related knowledge in Germany by applying the same method. Thus, a telephone survey consisting of open-ended questions being followed by single-choice or multiple-choice queries was conducted.

Recent studies in Germany also found that children and adults have difficulties to achieve oral cleanliness even when they perform to the best of their abilities (11–16). This and results of studies observing people's oral hygiene performance (12, 15–19) indicate that there might also exist knowledge gaps regarding proper oral hygiene behavior.

A second aim of the present study was therefore to record what people believe, what they have to pay attention to if they want to demonstrate particularly good oral hygiene behavior.

The present study thus aimed to assess periodontitis-related knowledge and knowledge regarding proper oral hygiene behavior in Germany. Former participants of the representative DMS V were contacted by

telephone and were asked a series of open-ended questions and single- and multiple-choice queries partly identical and partly similar to those asked in 2007. Three age groups were assessed: 16-year olds, younger adults and seniors. This allows for comparison between age groups and helps to identify specific educational needs within these groups.

## Methods

The study protocol was approved by the institutional review board of the Medical Association North Rhine, Düsseldorf, Germany (No. 2013384).

### Participants and date of data assessment

Data assessment for the present study took place from April to June 2018. Participants were former participants of the DMS V (10) which took place in 2014 and comprised representative samples of 12-year olds (N = 1468, now 16-year olds), younger adults (aged 35–44; N = 966, now aged 39–48) and seniors (aged 65–74; N = 1042, now aged 69–78). 91 % of the participants of that study agreed being contacted for further studies. The present study aimed to assess random selections of N = 333 within each of the age groups, thus to a total of 999 participants.

Information regarding age, sex, and highest degree of education were available by the data entries of the DMS V. After their participation in the DMS V study, the participants were included in a panel and contacted every six months for address and contact maintenance.

The current contact data of the participants were always requested and updated if necessary. For those persons who did not have a telephone number, an internal search was carried out first.

Subsequently, the participants were contacted in two concrete steps with regard to their telephone number.

The search for the telephone numbers was then completed. Of the 3057 target persons from the DMS V, telephone numbers were already available for 1897 persons. The search described above was carried out on 1020 persons. Further 140 telephone numbers could be identified, so that from altogether 2037 persons telephone numbers for this study were present.

### Structure of the survey

For the current survey the authors of the present study revised, updated and complemented the survey conducted in 2007 (9) which based on a patient information brochure of the German society for Periodontology.

Participants were asked 5 types of questions to be considered in this analysis:

- Open-ended questions with no selection of answers provided by the interviewer
- Single choice queries where participants had to chose one out of several alternatives

- Multiple choice queries where participants were asked to choose all alternatives which they thought to be correct; no limits were given regarding the number of selections
- Statements for which participants should decide whether they considered them to be right or wrong
- Filter questions leading to prespecified further questions depending on the answers given by the participants

These questions related to

- the definition of periodontitis (block 1; open-ended vs. single choice),
- consequences of periodontitis (block 2; open-ended vs. multiple choice),
- risk factors of periodontitis (block 3; open-ended vs. multiple choice),
- prevention, early recognition and prevalence of periodontitis (block 4; statements which were right or wrong),
- devices indispensable for proper oral hygiene (block 5; open-ended vs. multiple choice),
- aspects to look out for regarding proper oral hygiene (block 6; open-ended),
- locations particularly important to clean (block 7; open-ended).

Other questions whose analysis would go beyond the scope of the present paper and which will therefore be evaluated in a subsequent analysis related to specific attitudes, health experiences, and health behaviors of the participants. Appendix 1 shows the whole structure of the interview including interviewer instructions and highlights those questions considered in the present analysis.

### **Instruction of the interviewers**

Long-term permanent employed professional interviewers specialized in computer assisted telephone interviews (CATI) conducted the interviews. In order to minimize interviewer effects on answering behavior they received no information regarding the correct or expected answers. None of the interviewers was related to dentistry.

Furthermore, interviewers had no other information about the individual participants as their name and that they were former participants of the DMS V. Interviewers received a specific and detailed face to face training for the present study regarding techniques of questioning and categorization of answers given to open-ended questions.

All interviewers accomplished several test-interviews prior to interviewing real participants.

Interviewer instructions were refined according to the results of the test-interviews.

Interviewers categorized answers to open-ended questions during the interview by allocating them to pre-specified categories. When open-ended questions were followed by single- or multiple-choice queries regarding the same content the pre-specified categories corresponded to the choices presented there. Answers not corresponding to any of the pre-specified categories were saved in text form. RJ and RD jointly discussed whether these answers could be re-categorized into one of the pre-specified categories (e.g. in question 1 answers like “bleeding of the gum” were re-categorized into “gingival inflammation”), or

summarized within a new category, or should be kept as “miscellaneous” answers. Decisions for pre-categorization were only made if both authors agreed in doing so. Most answers to most questions, however, were already covered by the pre-categorization and thus could be easily categorized by the interviewers. For quality assurance, the supervisor in the CATI studio monitored 10 % of the interviews.

### Statistical data analysis

All analyses were run by means of SPSS 26 (IBM, Amrook, USA). Frequencies of positive answers to any item were computed for each age group (16 yrs, 39–48 yrs, 69–78 yrs). When frequencies were below 10% or above 90% no further analyses were run regarding differences between age groups, males and females or highly vs. lower educated participants. In all other cases the effect size Cramer’s V regarding differences between age groups and regarding differences between males and females and highly vs. lower educated within age groups were computed by the cross tables procedure of SPSS. Effect sizes of Cramer’s V = 0.1, Cramer’s V = 0.3, Cramer’s V = 0.5 are considered small, medium or large, respectively. All data are presented along with the 95% confidence intervals (20); recommended method for single samples).

### Informed consent and data availability

The written consent obtained from the study participants to participate in the study did not include making their data publicly available. Therefore, the datasets generated and analysed during the current study are not publicly available.

## Results

Table 1 shows the sample characteristics regarding age groups, gender and education. Data of one senior were flawed and thus not reported. The flow diagram of patient recruitment is shown in Appendix 1.

Table 1  
Sample characteristics

	<b>16-year olds</b>	<b>adults (39–48)</b>	<b>seniors (69–78)</b>
N	333	307	332
% women	47.4	57.3	57.2
% at least UED	./.	49.2	30.7*
UED: University entrance diploma; * data of 10 seniors are missing			

All participants of the current survey were also participants of the representative DMS V (10). The current subsample shows a very low though statistically significant advantage regarding education as compared

to those participants of the DMS V who did not contribute to the current survey (adults: 49.2% vs. 42.8%,  $p = .007$ , Cramer's  $V = 0.088$ ; seniors: 30.7% vs. 25.8%,  $p = .015$ , Cramer's  $V = 0.077$ ). Similarly, a small though significant preference for a residence in Western Germany was found in the current subsample of 16-year olds (76.6% vs. 66.8%,  $p = .001$ , Cramer's  $V = 0.089$ ) and seniors (72.6% vs. 66.5%,  $p = .048$ , Cramer's  $V = 0.061$ ). No statistically significant difference was found between the current subsample and the remaining DMS V participants regarding sex (all  $p > 0.05$ ).

### **Sociodemographic factors and survey results**

Effect sizes regarding differences between males and females were small (all Cramer's  $V < 0.218$ ). Similarly, effect sizes regarding educational groups only once exceeded the conventional threshold for medium effect sizes (Cramer's  $V = 0.30$ ) and remained below Cramer's  $V = 0.225$  in all other cases. Effect sizes regarding differences between age groups tended to be larger though medium effect sizes were observed rarely. Effect sizes of Cramer's  $V \geq 0.1$  are depicted in the respective Figures, which describe the results.

### **Periodontitis related knowledge**

Figure 1 shows answers participants gave to the question "What is a periodontitis – also often named parodontosis". Answers related to gingivitis ("inflammation of the gum" and "painful inflammation of the gum with overgrowth") were grouped as were answers related to alveolar bone loss ("age-related or congenital loss of the jaw bone"; "hereditary loss of the jaw bone"). Figure 2 shows answers regarding consequences of periodontitis. 6% of participants gave answers to the open-ended question that were not included in the pre-categorized alternatives. Among them were inflammations in general (1.4%), gastrointestinal problems (1.5%), rheumatoid complaints (1.6%); complaints with one's angles (1.0%). All others were named by less than 1% of the participants. All answers regarding cardiovascular disease (e.g. high blood pressure; myocardial infarction) were grouped. Answers regarding risk factors of periodontitis are presented in Fig. 3.

Most answers to the open-ended question which were not pre-categorized referred to oral hygiene (e.g. "bad tooth-brushing"; "bad oral hygiene") and were grouped together with the categories "calculus" and "plaque bacteria" into "oral hygiene". Other factors not pre-categorized which were named by more than 1% of the participants were "bad nutrition" (5.8%) and "unregular visits at the dentists" (2%). Figure 4 shows the frequency of correct answers to a series of statements where participants had to decide whether they believed they were right or wrong. The graph does not show statements correctly answered by more than 90% of the participants: These were "Only older persons suffer from periodontitis" (> 94% in all age groups) and "If gums are bleeding, one should skip oral hygiene for some days" (> 94% both, in 16-year olds and adults, and > 85% in seniors).

### **Knowledge regarding proper oral hygiene behavior**

When participants were asked which devices are indispensable for proper oral hygiene more than 90% selected toothbrush and tooth paste, and less than 10% gingival stimulator and tooth whitener (data not shown).

Figure 5 shows how often other devices were actively named (open-ended question) or selected (multiple choice query). The pre-categorized answer “antibacterial mouth rinse” though selected by 50% of the participants is not included in the graph. This is because from the answers to the open-ended question it became obvious that most people did not know whether they were talking about an antibacterial mouth-rinse solution or a cosmetic mouth rinse.

Since recommendations according the preferable device for proximal hygiene differ and since current scientific evidence regarding the superiority of one device above the other is low (21) additional analyses grouped tooth floss and interdental brushes. These analyses revealed that 73.3% (95% CI: 68%-78%) of the 16-year olds, 85.3% (95% CI: 81%-89%) of the adults and 57.8% (95% CI: 52%-63%) of the seniors actively mentioned at least one of these devices as being indispensable.

If participants named or selected a device they were also asked by an open-ended question how often it should be used.

Regarding the use of a toothbrush 84.3% (95% CI: 82%-86%) answered it should be used at least twice daily and 28.1% (95% CI: 25%-31%) at least three times a day. With respect to tooth floss 82.7% (95% CI: 80%-85%) stated at least twice a day and 29% (95% CI: 26%-32%) voted for at least three times a day. Similar frequencies were named by those who thought tooth woods ( $\geq 1$  per day: 71.1%, 95% CI: 61%-79%;  $\geq 2$  per day 28.9%, 95% CI: 21%-39%) or tooth picks ( $\geq 1$  per day: 76.7%, 95% CI: 69%-83%;  $\geq 2$  per day: 33.1%, 95% CI: 26%-41%) were indispensable.

Figure 6 shows what people answered to the open-ended question what they should look out for if they want to clean their teeth particularly thoroughly (here, they received no corresponding multiple-choice query). Beneath the categories shown in Fig. 6 further pre-specified categories referred to different aspects of the toothbrush (powered vs. manual, size, age, material of the bristles) but were named by less than 10% of the participants.

Participants were also asked to further specify their answers where appropriate.

Regarding technique 46.1% (95% CI: 41%-51%) named circling brushing movements as the appropriate technique and 31.8% (95%CI: 28%-36%) vertical movements from “red to white”. These selections, however, differed between age groups. While more than 50% of 16-year olds and adults named circling movements, less than one third of the seniors did so. On the other side, only 15% of the 16-year olds but more than one third of adults and seniors named vertical movements. Less than 5% of all age groups named (or described) the modified bass technique and less than 5% scrubbing movements. Regarding duration the majority named at least 2 minutes (95.9%; 95% CI: 93%-98%) and 64.7% (95% CI: 60%-69%) even stated at least three minutes. Regarding the pressure of the toothbrush the majority of those who had named this aspect specified that one should not brush too firmly (84.1%; 95% CI: 78%-89%).

Irrespective of their answer given to the question what one should look out for all participants were asked to specify which areas are particularly important to clean.

Figure 7 shows the responses to this open-ended question (multiple responses possible) named by more than 10% of the participants. Approximately 95% of all age groups gave an answer to this question. More than a quarter only answered non-specifically like “all teeth”, “everywhere” and gave no further answer (see Fig. 7). Less than 2% named the tongue and less than 10% answered “all sites of the teeth” (data not shown).

### **Relationships between selected aspects of periodontitis related knowledge and knowledge regarding proper oral hygiene behavior**

It became evident so far that many people did not have an active awareness of the definition of periodontitis and oral hygiene as a risk factor of periodontitis. Furthermore many people did not know that the cleaning of occlusal surfaces is not important for the prevention of periodontitis, that caries is not the most frequent cause for tooth loss in adults and that dental calculus can be avoided. An exploratory analysis therefore compared those who did not have an active awareness or could not give the correct answer regarding these items to those who did. This analyses comprised all items of block 4 (statements to prevention etc., Fig. 4), block 5 (open-ended part; indispensable devices, Fig. 5), block 6 (aspects to look out for, Fig. 6) and block 7 (locations Fig. 7). Most of these comparisons revealed small effect sizes below Cramer's  $V = 0.2$ .

Differences exceeded Cramer's  $V = 0.2$  regarding the following comparisons:

Participants who did not know an answer to the open-ended question regarding the definition of periodontitis vs. those who gave an answer

- less often named any aspects regarding oral hygiene when asked for risk factors of periodontitis by open-ended question (15.1% vs. 32.3%, Cramer's  $V = .203$ )
- less often named interdental brushes when asked by open ended question which devices are indispensable for proper oral hygiene (12.1% vs. 34%; Cramer's  $V = 0.261$ )
- more often agreed with the statement that brushing of occlusal surfaces was of special importance in order to avoid a periodontitis (75.5% vs. 55.6%; Cramer's  $V = 0.211$ )
- more often agreed with the statement that one recognizes periodontitis in early stages by frequent tooth aches (65.5% vs. 27.4%; Cramer's  $V = 0.381$ )
- more often disagreed with the statement that untreated periodontitis may lead to loss of otherwise healthy teeth (79% vs. 94.4%; Cramer's  $V = 0.225$ )

Participants who agreed with the statement that brushing of occlusal surfaces was of special importance in order to avoid a periodontitis (as compared to those who denied this statement)

- more often agreed with the statement that in early stages one would recognize periodontitis by frequent tooth aches (57.1% vs. 27.6%; Cramer's  $V = 0.281$ )

- more often agreed that caries was the most frequent reason for tooth loss in adult age (67.1% vs. 40.2%; Cramer's  $V = 0.258$ )

## Discussion

The data in the current survey indicate knowledge gaps regarding periodontitis in all age groups.

Even when presented the correct definition of periodontitis only a minority of less than ten percent of the participants recognized it within a number of alternatives (see Fig. 1). This is remarkable especially for adults and seniors as according to the DMS V more than 50% of the adults and more than 70% of the seniors suffer from periodontitis. Furthermore, more than 30% of adults and seniors and nearly all young people could not answer the open question regarding the definition at all. While one might consider active knowledge of the definition of periodontitis to be of minor importance, the analyses of relationships between this item and others (see results section) indicate the opposite. Still, especially results regarding the single-choice query indicate that a majority could at least associate periodontitis to gingivitis or exposed tooth necks. This suggests that there is at least some awareness of a connection between these conditions and periodontitis. However, the answers to the following questions raise doubts that this reflects a more profound understanding. Less than 50% of adults and seniors and less than 20% of adolescents could actively name at least one consequence or risk factor, respectively. On the other side, passive recognition of the most immediate consequences (persistent damage of the jawbone and tooth loss) was excellent. Yet, the high rate of selections of obviously wrong alternatives like "sore throat" or "damage of the temporomandibular joint" (see Fig. 2) indicate that answers often were guessed (perhaps following the heuristics to preferably select those alternatives which are closest to the teeth). The same holds true for risk factors. Again, recognition of some very important correct answers was excellent. However, participants selected wrong alternatives about the same frequency (see Fig. 3).

These observations raise the impression that people's knowledge about periodontitis is rather erratic. Responses to the statements presented in block 4 support this notion. Even though altogether more than 80% of the interviewees of all age groups associated periodontitis with gingivitis or exposed tooth necks more than 70% of the adolescents and seniors and nearly 50% of the adults believed that it was particular important to clean one's occlusal surfaces in order to prevent periodontitis. Furthermore, though more than 90% of all age groups recognized bad oral hygiene as an important risk factor of periodontitis, 45% of the adolescents and 30% of adults denied the causal role of dental plaque. Additionally, 40–65% believed that one cannot avoid the emergence of dental calculus and 35%-55% denied that one can prevent periodontitis by very good oral hygiene (see Fig. 4).

These two answers, however, fit to the fact that most participants affirmed that the fewest patients manage to sustain optimal oral hygiene without the help of their dentist.

In terms of psychology these answers indicate a high external locus of control for oral hygiene and periodontitis which might impede efforts of the patients themselves.

Some of the answers people gave in those questions referring to periodontitis related knowledge give the impression that their awareness regarding caries exceeds that regarding periodontitis and that they might

even confuse caries and periodontitis. More than 90% selected excessive sugar consumption as an important risk factor (see Fig. 3), a majority believes that the most frequent cause for tooth loss in adults is caries and that occlusal surfaces are important for periodontitis. Additionally, 80% of adolescents believe that one recognizes periodontitis by frequent tooth aches. Answers to these questions are further interrelated. Such an orientation of the answers towards caries is understandable considering that during childhood when oral health education training begins its focus is on the prevention of caries. The present survey indicates that this early experiences might interfere with the adoption of new knowledge regarding other oral disease in adolescence and adulthood.

### **Changes in knowledge from 2007 to today**

Regarding active awareness of periodontitis-related topics results of the survey today resemble those of the survey in 2007 (9). When we compare the same age groups and control for education, no consistent differences emerge. Knowledge regarding the definition of periodontitis was even worse today. Furthermore, adults today mentioned oral hygiene less often actively as risk factors as compared to 2007 while highly educated seniors today named it more often than in 2007. Today's seniors also actively mentioned cardiovascular disease as consequence more often than those in 2007.

### **Knowledge about proper oral hygiene**

Regarding proper oral hygiene answers of nearly all participants correspond to the recommendation of brushing one's teeth at least twice daily for at least two minutes (22). Furthermore, approximately 75% of the adolescents and 85% of the adults and still 60% of the seniors actively mentioned interdental brushes and/or tooth floss as being indispensable. In addition, nearly all of those who named any of these devices suggested their daily use. These persons obviously are aware about *what* to do to maintain proper oral hygiene and how often they should do it and they even report to behave accordingly (23). But what about awareness regarding the how and where? Fig. 5 shows that most interviewees had difficulties to actively recall what they should look out for when they are cleaning their teeth. The aspect most often named was brushing technique. At the same time, scientific evidence is missing whether it is important to apply a specific brushing technique and which one would bring about the best results (6, 22).

Furthermore, even though a majority had named devices for proximal hygiene as being indispensable less than 15% mentioned proximal hygiene as one aspect of oral hygiene they should look out for and less than 25% mentioned proximal surfaces when being asked for sites they should consider particularly.

This fits results of two current video analyses of oral hygiene performance.

In these studies, people were asked to perform oral hygiene to the best of their abilities. Only 31% of university students and only 15% of a random sample of 18-year olds even used devices for proximal hygiene. In addition, most of these participants used it in an un-proper way and did not reach all proximal spaces (12, 16).

Current tooth-brushing recommendations often stress brushing systematics as an important factor, as systematics should help to consider all teeth and surfaces while brushing and not to neglect areas. Interviewees, however, rarely mentioned this aspect. Again, this finding confirms what studies on actual tooth brushing performance show. These studies revealed that most people brush their teeth unsystematically and often neglect a number of areas while brushing (12, 15–19). Furthermore, a comparison between a cohort of 18-year olds that had been asked to brush their teeth as they normally do and a comparable cohort been asked to brush their teeth to the best of their abilities revealed no improvement of systematics. While “as usual” brushers already brushed the frontal teeth and the occlusal surfaces disproportionately long “best ability” brushers brushed them even longer (12).

When asked about sites of particular importance 25% of the 16-year olds and more than 40% of adults and seniors could only give a very unspecific answer like “everywhere” or “all teeth”. Less than 10% mentioned the gingival margins, a region of specific importance when it comes to the prevention of periodontal disease. Again, this reflects findings of a series of studies in different age groups, which found that plaque persisted at 50% of the gingival margins or more even when people performed oral hygiene to the best of their abilities (11–16). Similarly, in these and the above-mentioned observational studies participants often neglected inner surfaces. The present survey confirms that only a minority appears to be aware of the inner surfaces as one region one look out for.

These results indicate that most people have a good awareness of which oral hygiene aids to use and how often.

An awareness of how to do it, on the other hand, is less widespread.

This and the results regarding periodontitis related knowledge might help to clarify an apparent contradiction of epidemiological research in dentistry: While most people state to perform tooth brushing at least twice a day and proximal hygiene at least daily, prevalence of periodontal disease like gingivitis and periodontitis is high (10).

The present survey confirms that people are motivated to perform oral hygiene.

However, most neither are aware of HOW they could perform oral hygiene properly nor are sufficiently aware of WHY certain aspects are so important.

### **Sociodemographic factors**

Interestingly, demographic factors appear to be of minor importance when it comes to knowledge regarding periodontitis or proper oral hygiene. If there were any groups differences between age groups, higher and lower educated participants or men and women they tended to be small. Furthermore, group differences did not consistently point into one direction. This indicates that there is a need for improved education on periodontal disease and proper oral hygiene across the population, regardless of age, education or gender.

### **Limitations**

The present survey is an observational study and neither intends nor justifies causal inferences. Its major aims are to describe the current state of specific knowledge in the population and to infer hypotheses for future research. The sampling technique was random selection, which should have led to a likewise representative sample. However, the response rate of adults was too low to reach the intended sample size. This indicates that especially the subsample of adults might not be representative for German adults of the same age. Additionally, data from the present survey cannot readily be generalized to other nations. However, the meta-analysis of Varela-Centelles et al. (2016) indicates that results in other nations might be similar. Within a telephone interview, one cannot fully preclude interviewer effects. However, professional interviewers conducted the interviews that had a specific training to minimize interviewer biases. A supervisor further controlled proper conductance of the interviews throughout the study. Additionally, 12 interviewers participated in data sampling. This enhances the probability that any interviewer-effects affected data unsystematically instead of biasing them into one direction.

## **Conclusions**

The current knowledge about periodontitis throughout the population in Germany appears to be erratic and often to be derived from knowledge about caries. However, because primary, secondary, and third prevention of periodontitis strongly depend on oral health behavior, an appropriate understanding of the disease, including risk factors and prevention options, is necessary in order to be able to decrease the burden of the disease in the long term. In view of the high prevalence today, educational measures, tailored to different age groups are needed to reduce the prevalence and incidence of the disease in future. A universal strategy is predestined to have a primary preventive effect (incidence reduction), whereas a target group-specific or indicated strategy has a particularly secondary preventive effect with the aim of early detection and early treatment (prevalence reduction; (24)).

## **Declarations**

### **EHTICAL APPROVAL AND CONSENT TO PARTICIPANTS**

The current study is approved by the Institutional Review Board (IRB) of the North Rhine medical association, Duesseldorf. All methods were carried out in accordance with relevant guidelines and regulations. Informed consent was obtained from all subjects. Also, an Informed consent was obtained from parents of subjects under 18 years of age to participate in the study.

### **CONSENT FOR PUBLICATION**

Not applicable.

### **AVAILABILITY OF DATA AND MATERIALS**

The written consent obtained from the study participants to participate in the study did not include making their data publicly available. Therefore, the datasets generated and analysed during the current

study are not publicly available. However, access to the data can be requested from Andreas Rainer Jordan (senior author).

## **COMPETING INTERESTS**

The authors declare that there is no conflict of interests according to the Uniform Requirements for Manuscripts Submitted to Biomedical Journals. The interpretation of data and presentation of information is not influenced by any personal or financial relationship with any individual or organization.

## **FUNDING**

The Fifth German Oral Health Study (DMS V) and this telephone survey was financed by the German dental profession via the German Dental Association and the National Association of Statutory Health Insurance Dentists. However, the contents of this paper are solely the responsibility of the authors.

## **AUTHORS' CONTRIBUTIONS**

All authors listed in the paper have contributed sufficiently to fulfill the criteria for authorship according to ICMJE guidelines. All authors read and approved the final manuscript.

RD is principal investigator and writing the manuscript

RAJ is principal investigator and writing the manuscript

## **ACKNOWLEDGEMENTS**

The study was coordinated by Kantar Health GmbH, Munich (Germany). We thank Dr. K. Kuhr (IDZ) for assistance in preparation of the figures.

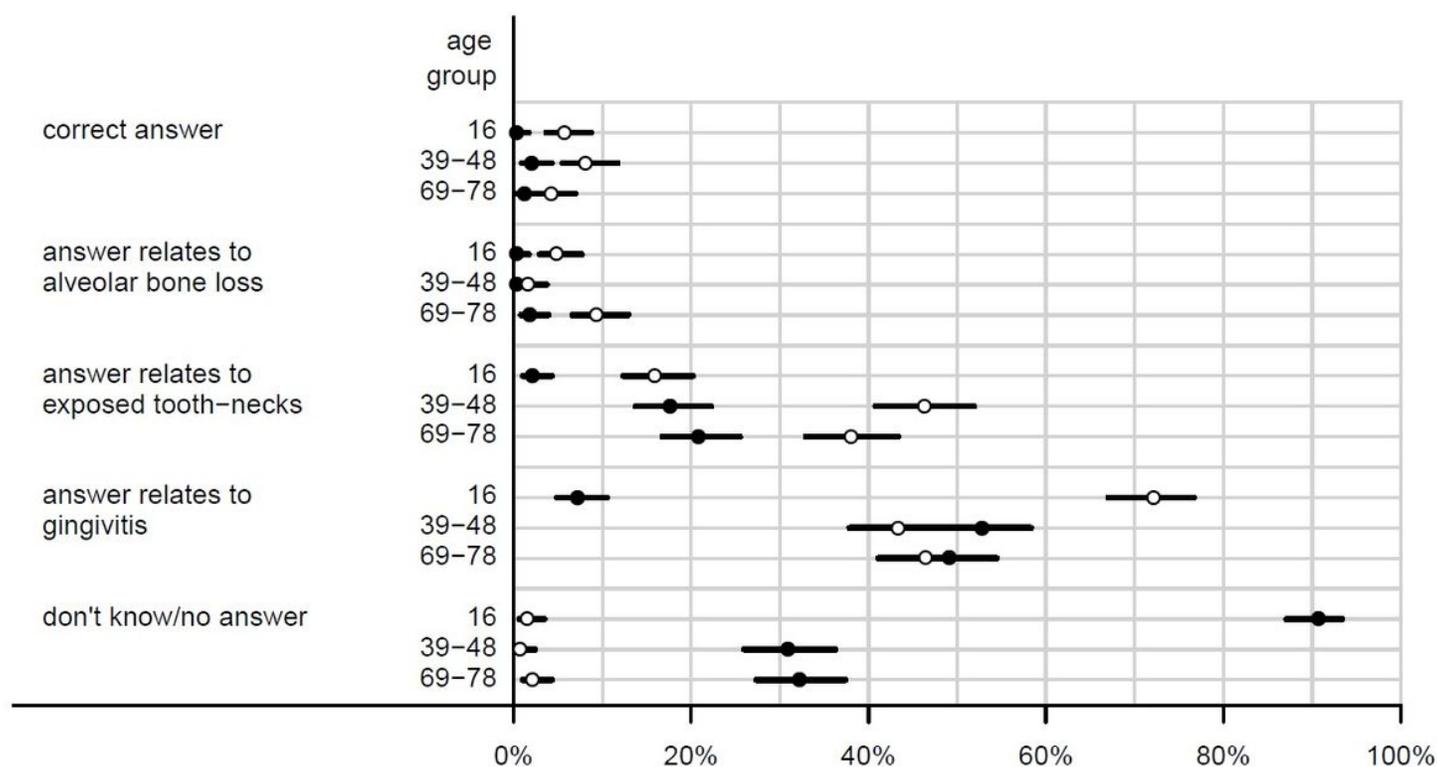
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## Figures



**Figure 1**

Responses to block 1: „What is periodontitis“ (percentages and 95% CI). ● active knowledge; ● passive knowledge Active knowledge: Answers given to open-ended question (multiple responses possible); Passive knowledge: Selections in single-choice query. Answers related to gingivitis (“inflammation of the

gum” and “painful inflammation of the gum with overgrowth”) were grouped as were answers related to alveolar bone loss (“age-related or congenital loss of the jaw bone”; “hereditary loss of the jaw bone”).

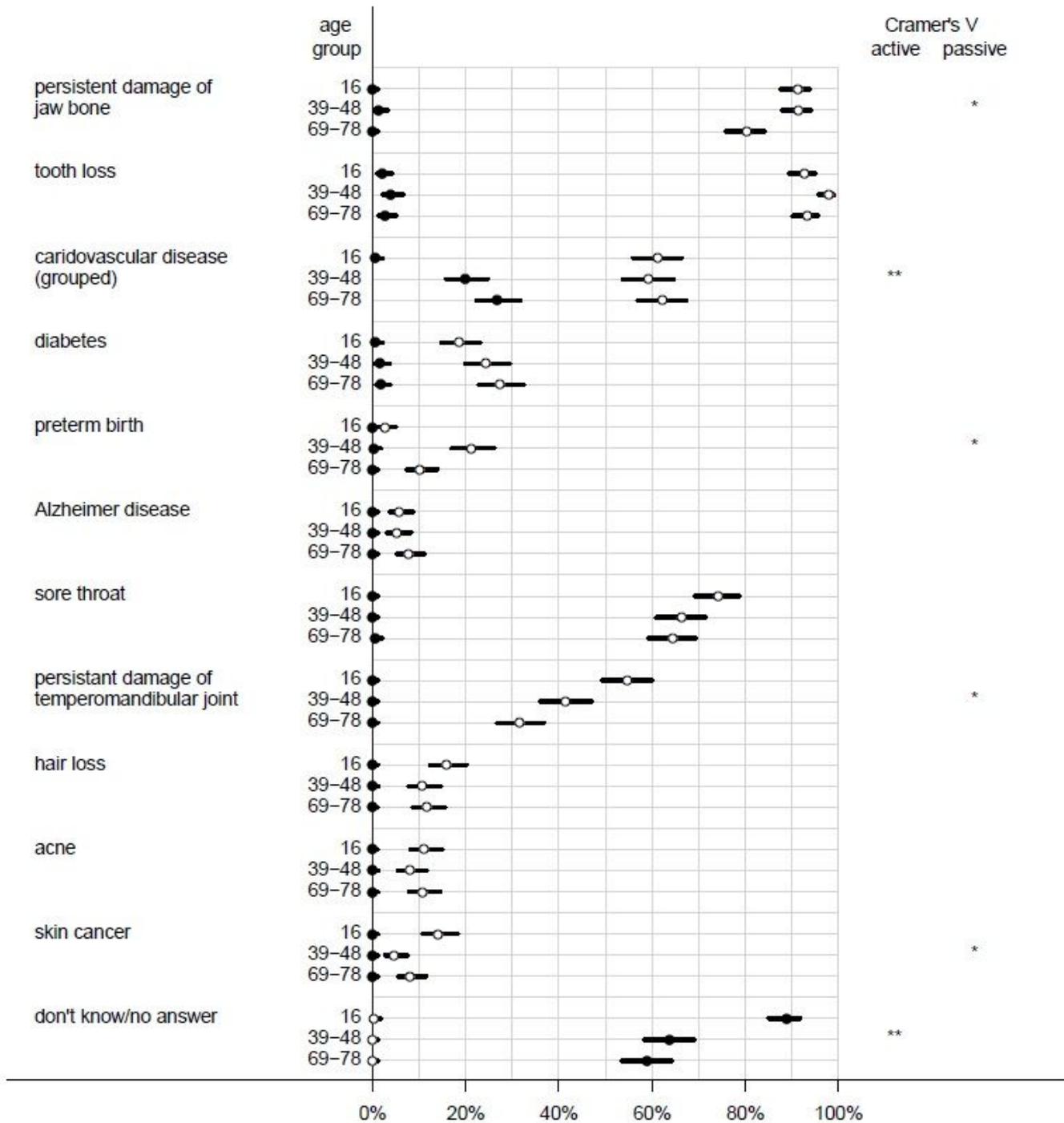
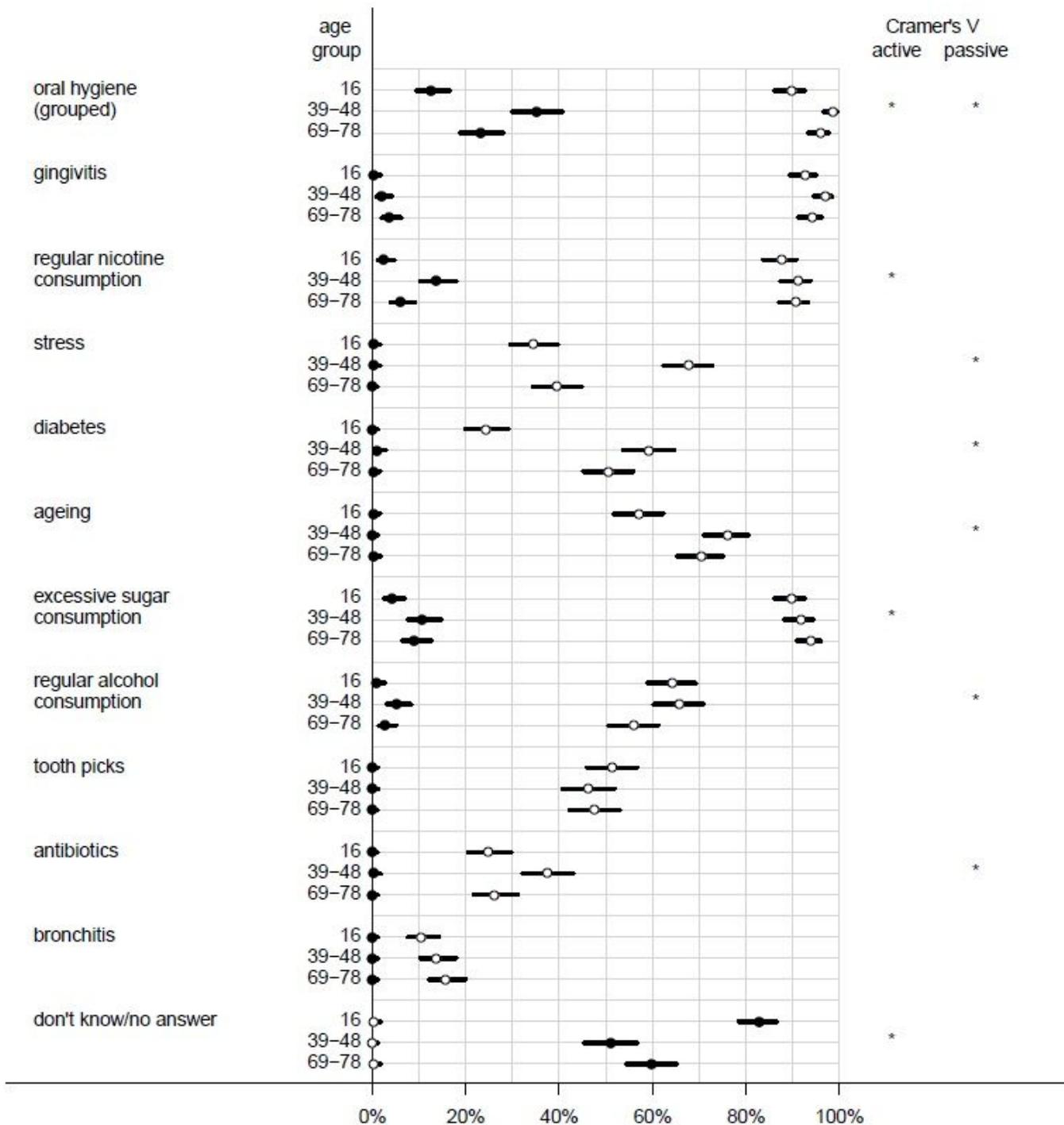


Figure 2

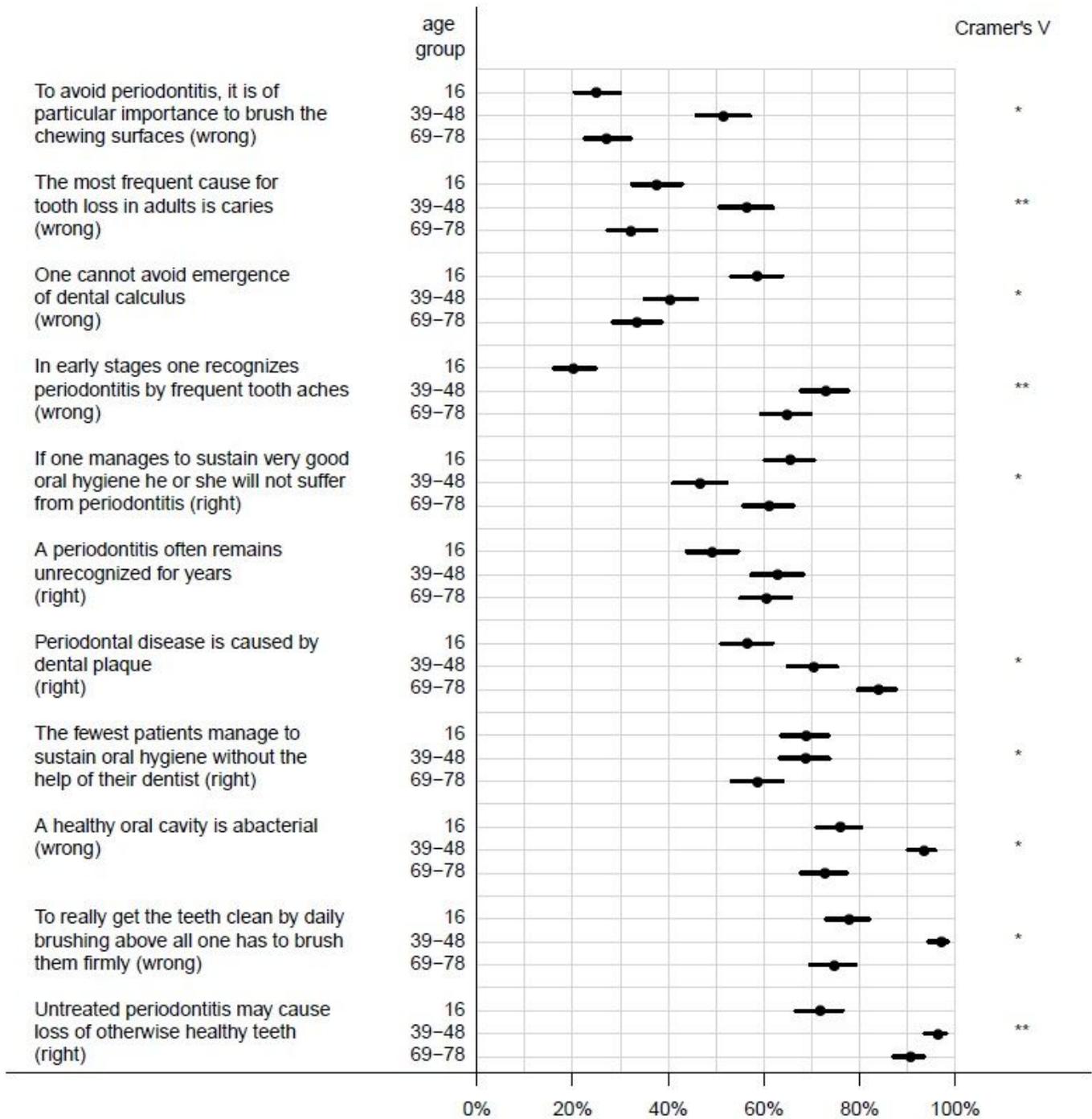
Responses to block 2: „People suffering from periodontitis do have an increased risk for other disorders; do you know any of these disorders?” (percentages and 95% CI). Legend: ● active knowledge; ● passive knowledge; \*/\*\*/\*\* Cramer's V for group difference >0.1/>0.3/>0.5 Active knowledge: Answers

given to open-ended question, multiple answers possible; Passive knowledge: Selections in multiple-choice query. Answers below the horizontal black line do not correspond to current scientific knowledge. 6% of participants gave answers to the open-ended question that were not included in the pre-categorized alternatives. Among them were inflammations in general (1.4%), gastro-intestinal problems (1.5%), rheumatoid complaints (1.6%); complaints with one's angles (1.0%). All others were named by less than 1% of the participants. All answers regarding cardiovascular disease (e.g. high blood pressure; myocardial infarction) were grouped



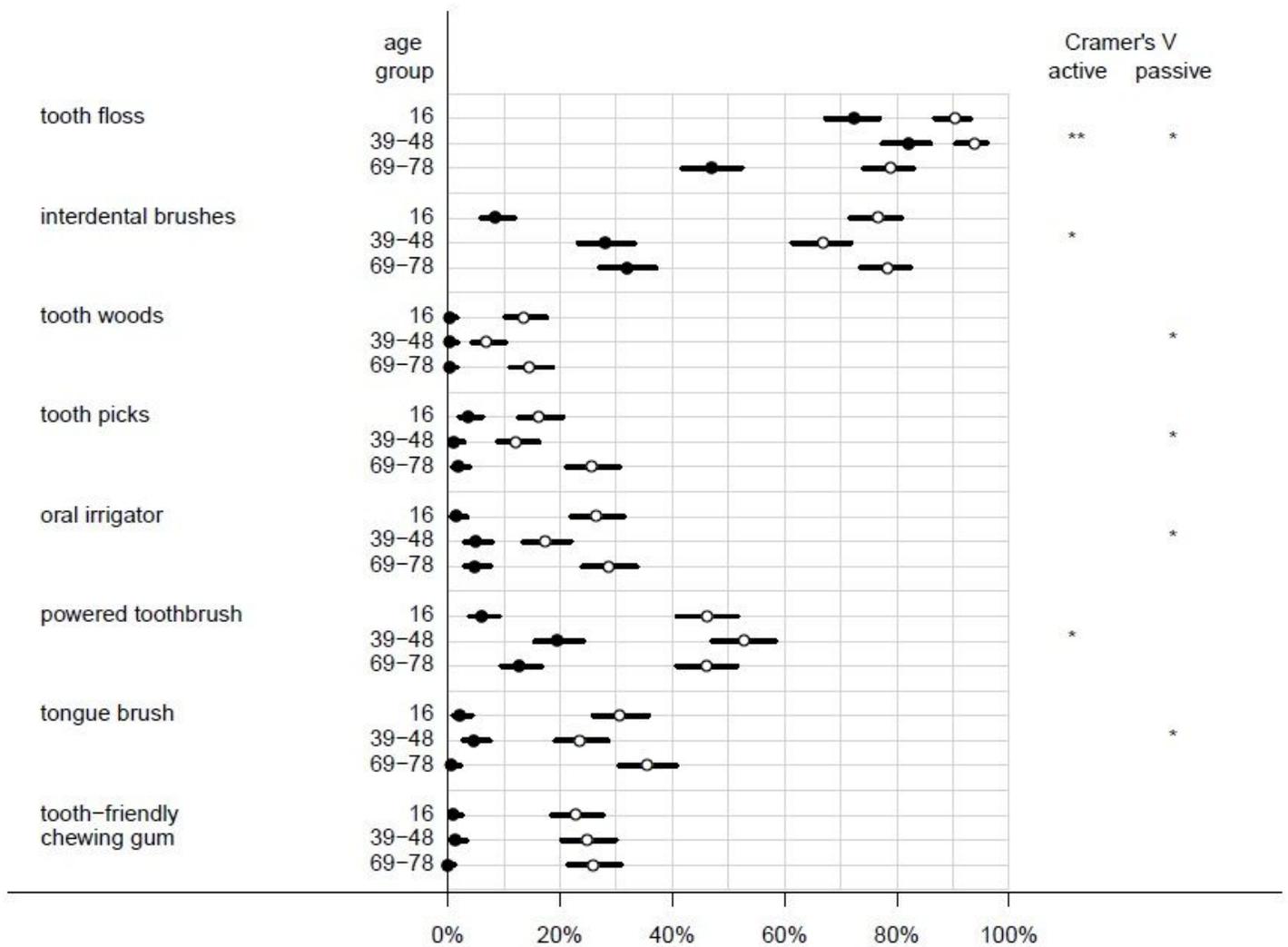
### Figure 3

Responses to the block 3: „Risk factors are factors, that are linked to a faster emergence or a more severe cause of periodontitis. Do you know any risk factors for periodontitis? (percentages and 95% CI). Legend: ● active knowledge; ● passive knowledge; \*/\*\*/\*\* Cramer’s V for group difference >0.1/>0.3/>0.5 Active knowledge: Answers given to open-ended question, multiple answers possible; Passive knowledge: Selections in multiple-choice query. Answers below the horizontal black line do not correspond to current scientific knowledge. Most answers to the open-ended question which were not pre-categorized referred to oral hygiene (e.g. “bad tooth-brushing”; “bad oral hygiene”) and were grouped together with the categories “calculus” and “plaque bacteria” into “oral hygiene”. Other factors not pre-categorized which were named by more than 1% of the participants were “bad nutrition” (5.8%) and “unregular visits at the dentists” (2%).



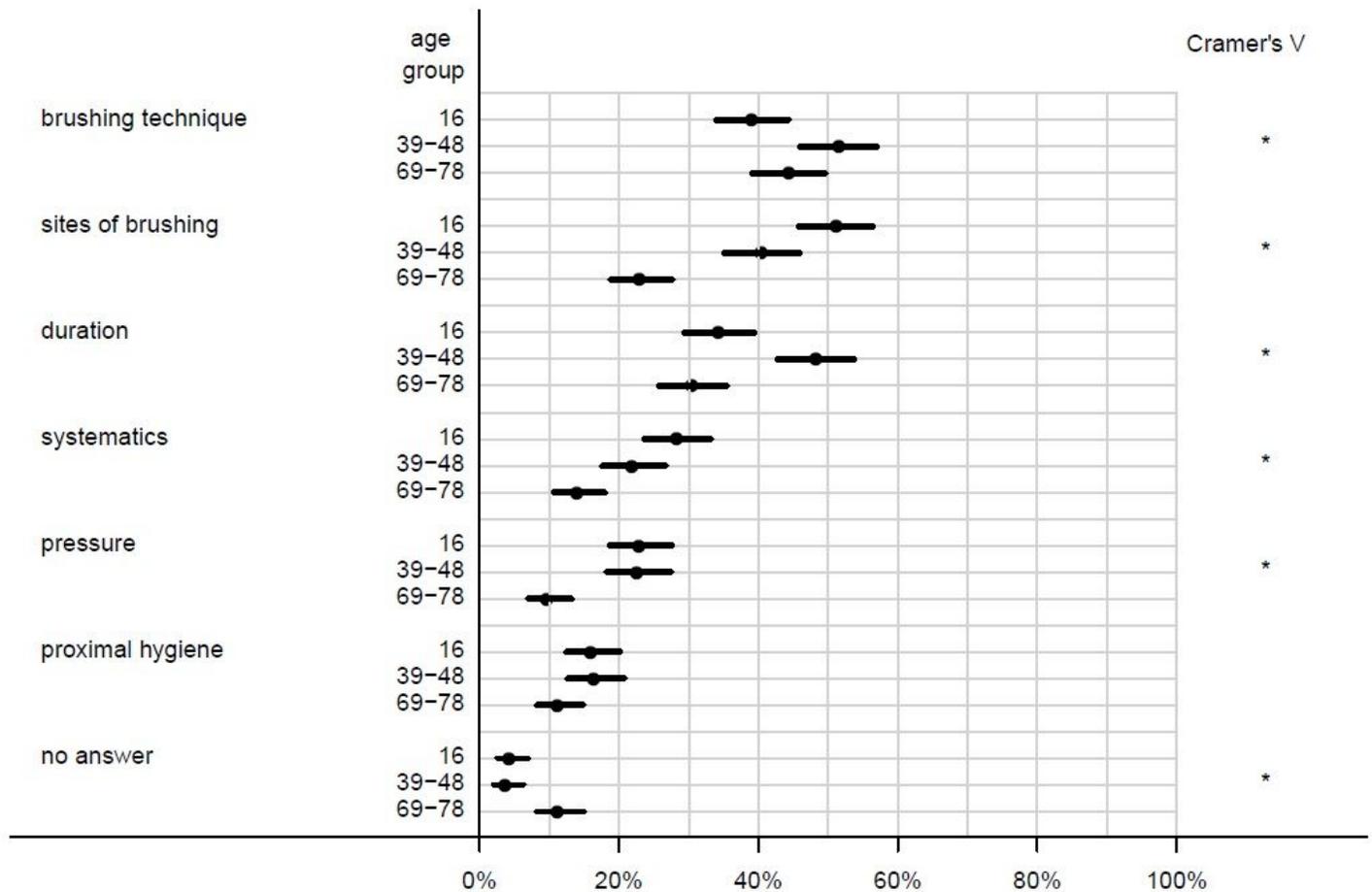
**Figure 4**

Correct answers given in block 4 (percentages and 95% CI). Legend: \*/\*\*/\*\* Cramer's V for group difference >0.1/>0.3/>0.5; The graph does not show statements correctly answered by more than 90% of the participants: These were "Only older persons suffer from periodontitis" (>94% in all age groups) and "If gums are bleeding, one should skip oral hygiene for some days" (>94% both, in 16-year olds and adults, and >85% in seniors).



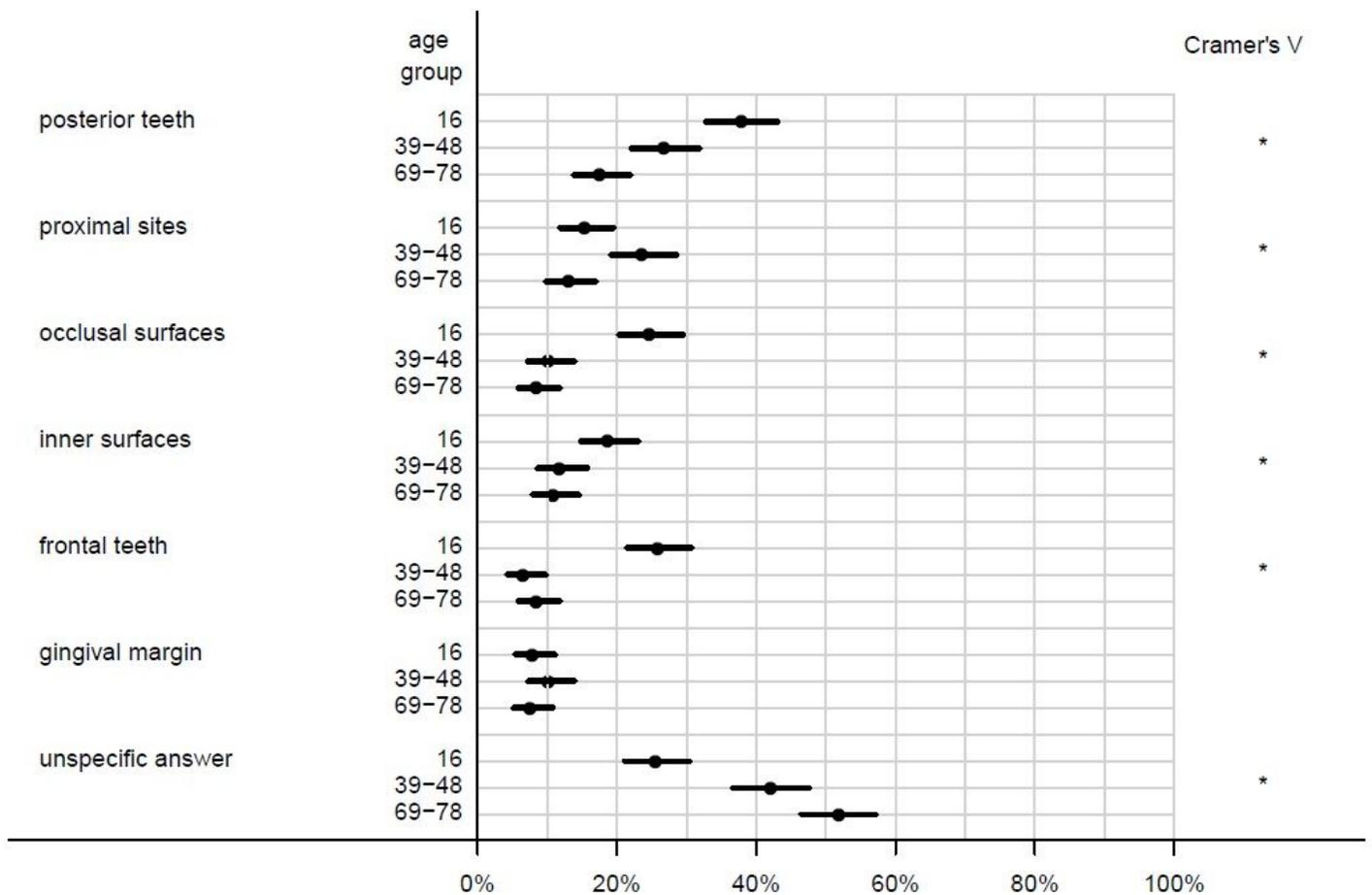
**Figure 5**

Responses to the block 5: „What, according to your information, are indispensable aids for maintaining good oral health (prevention of caries and periodontitis)?“ (percentages and 95% CI). Legend: ● active knowledge; ● passive knowledge; \*/\*\*/\*\* Cramer’s V for group difference >0.1/>0.3/>0.5 Active knowledge: Answers given to open-ended question, multiple answers possible; Passive knowledge: Selections in multiple-choice query. More than 90% selected toothbrush and tooth paste, and less than 10% gingival stimulator and tooth whitener (data not shown). The pre-categorized answer “antibacterial mouth rinse” though selected by 50% of the participants is not included in the graph. This is because from the answers to the open-ended question it became obvious that most people did not know whether they were talking about an antibacterial mouth-rinse solution or sa cosmetic mouth rinse.



**Figure 6**

Responses to the block 6 (active knowledge/open-ended question only; multiple responses possible): „What should you look out for if you want to clean your teeth particularly thoroughly, i.e. remove all plaque?“ (percentages and 95% CI). Legend: \*/\*\*/\*\* Cramer's V for group difference >0.1/>0.3/>0.5; beneath the categories shown other pre-specified categories referred to different aspects of the toothbrush (powered vs. manual, size, age, material of the bristles) but were named by less than 10% of the participants.



**Figure 7**

Responses to block 7 (active knowledge/open-ended question only; multiple responses possible): „In which area or areas is it particularly important to clean teeth and remove plaque?“ (percentages and 95% CI); Locations named by more than 10% of the participants are shown. Legend: \*/\*\*/\*\* Cramer's V for group difference >0.1/>0.3/>0.5; Approximately 95% of all age groups gave an answer. More than a quarter only answered non-specifically like “all teeth”, “everywhere” and gave no further answer. Less than 2% named the tongue and less than 10% answered “all sites of the teeth” (data not shown).

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [FigureA1.pdf](#)